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Dugong dugon.

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Dugong Lacépède, 1799

Dugong Lacépède, 1799:17. Type species *Dugong indicus* Lacépède, by original designation.
Platystomus Fischer, 1803:353. Type species *Platystomus dugong* Gmelin, by original designation [= *T. dugon* Müller].
Dugungus Tiedemann, 1808:554. Emendation (Latinization of *Dugong*).
Halicore Illiger, 1811:140. Type species *Trichechus dugong* Gmelin, by original designation [= *T. dugon* Müller].
Dugongidus Gray, 1821:309. Type species *Trichechus dugon* Müller, by original designation.

CONTEXT AND CONTENT. Order Sirenia, Family Dugongidae, Subfamily Dugonginae. The genus *Dugong* now includes only one species *Dugong dugon* as treated below.

Dugong dugon (Müller, 1776)

Dugong

Trichechus dugon Müller, 1776. Type locality Cape of Good Hope to the Philippines.
Trichechus dugung Erxleben, 1777:599. Type locality Indian Ocean.
Dugong indicus Lacépède, 1799. Type locality Indian Ocean.
Halicore hemprichii Ehrenberg, 1832. Type locality Barkan Island, Red Sea.
Halicore lottum Ehrenberg, 1832. Type locality Hauakal Island, southern part of Red Sea.
Halicore tabernaculi Rüppell, 1834:113. Type locality Red Sea.
Halicore australis Owen, 1847:328. Type locality Endeavor Strait, Cape York, Australia.
Halicore cetacea Heuglin, 1877:135. Type locality Red Sea.

DIAGNOSIS. Because the genus is monotypic, the following diagnosis applies to genus and species: body fusiform; hind limbs absent; tail a deeply notched fluke; forelimbs paddlelike and without nails; skin smooth; muzzle directed ventrally, terminating in a horseshoe-shaped disc (about 17 by 23 cm in adults); complete dental formula i 2/3, c 0/1, p 3/3, m 3/3, total 36, but the inner pair of upper incisors and all lower incisors and canines are vestigial (Mitchell, 1973; Lyman, 1939)—see Figure 1.

GENERAL CHARACTERS. Total length of adults is 2.4 to 4.06 m, corresponding weights are 230 to 908 kg (Heinsohn, 1972; Mani, 1960). The young are pale cream, and they darken with maturity to deep slate gray dorsally and laterally, slightly paler ventrally (Jones, 1960). Hair is short and sparsely distributed (30 to 50 mm apart) over the body except for dense bristles on the muzzle (Dexler and Freund, 1906*b*). The two mammae are axil-

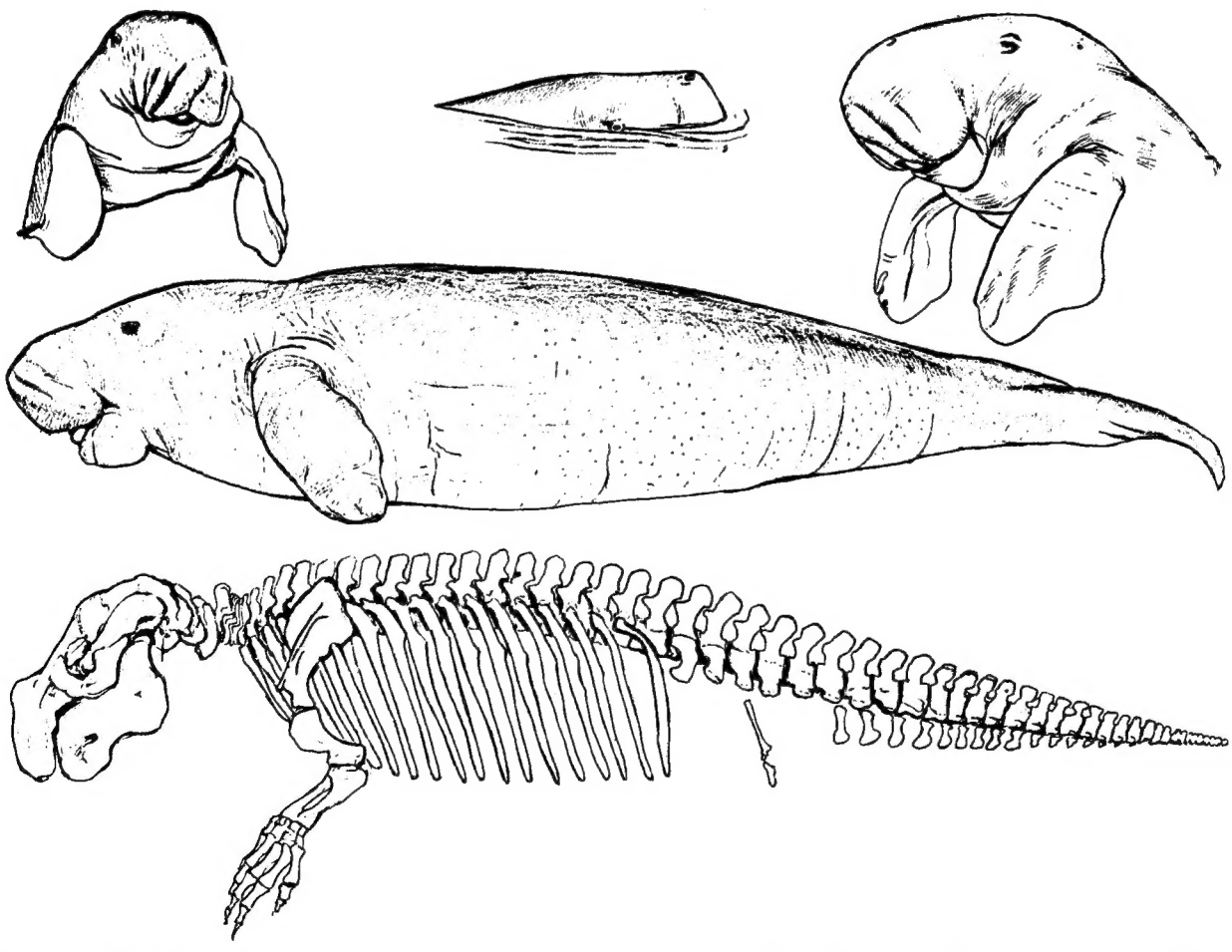

FIGURE 1. Drawings of several views of a dugong and its skeleton (from Kingdon, 1971, by permission of the author, who drew the illustrations also).

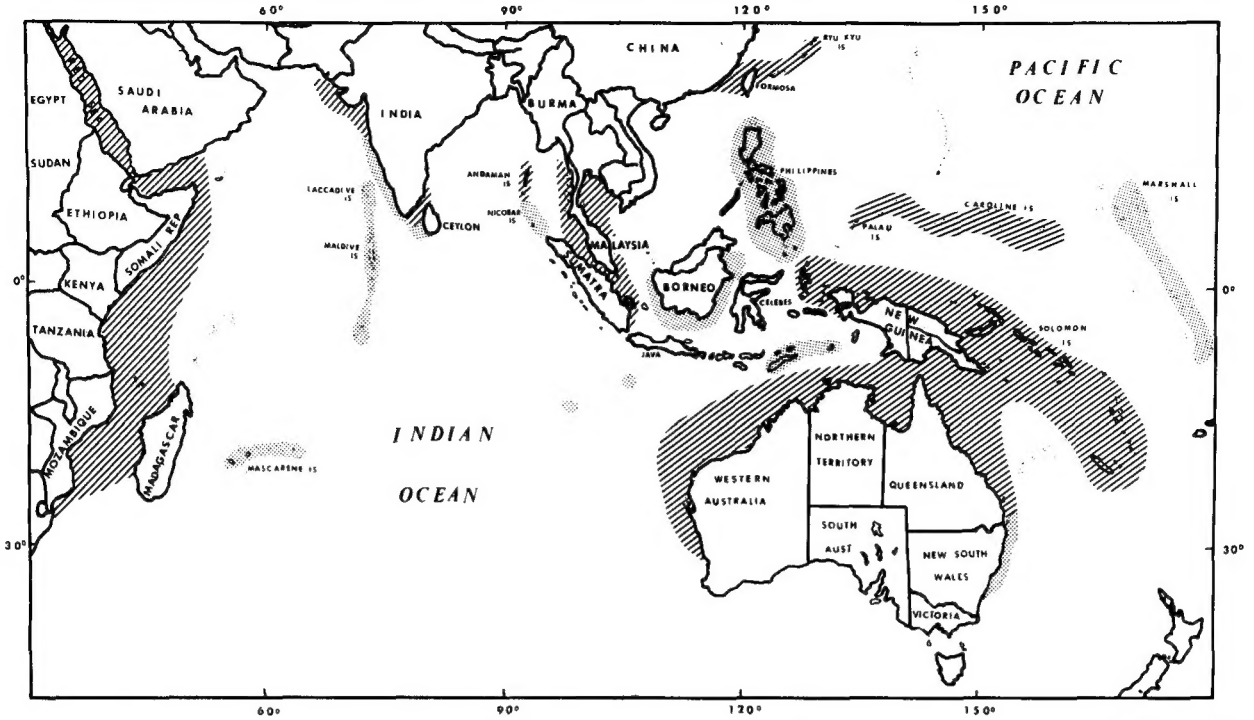

FIGURE 2. Map showing the geographic range of *Dugong dugon*. Hatching indicates present distribution and stippling shows areas from which dugongs have been extirpated.

lary. Nostrils are crescent shaped, approximately 18 mm in diameter and 16 mm apart, on the summit of the head and are closeable by muscular valves (Hill, 1945). Eyes are small, round, and black; eyelids have no lashes and close with a sphincter action. The ear opening is 3 mm in diameter and has no external pinna. Bones are extremely dense. The premaxilla is sharply downturned; nasal bones are absent. The molariform teeth replace each other from the rear. The outer pair of tusklike upper incisors are larger in males than in females. Norris (1960), after measuring 33 dugongs from Ceylon, all over 1.83 m in length, concluded that females grow larger than males. Heinsohn (1972), however, examined 69 individuals from Australia, ranging from 1.09 to 3.05 m, and found no significant sexual difference in size. Similarly, when only sexually mature (2.4 m in length or longer) animals were considered, there was no sexual dimorphism.

Detailed descriptions appear in Gohar (1957), Hill (1945), Dexler and Freund (1906*a*, 1906*b*) and Owen (1838). Black and white photographs of the dugong head are shown in Dexler and Freund (1906*b*) and anatomical drawings are included in Hill (1945).

DISTRIBUTION. The range of *D. dugon* (see figure 2) includes coastal waters within tropical and subtropical latitudes of the Indian and Pacific oceans. In Africa, the southernmost dugong record is a specimen that washed into Durban, South Africa, in 1966 (Best, 1968). The range extends northward along the coast to Egypt in the Red Sea (Stoddart, 1972; Gohar, 1957), but this distribution is not continuous. Populations are found in isolated channels and bays, and some local herds are known to have been extirpated. Dugongs were abundant off the shores of Madagascar in the early part of this century (Prater, 1929*a*), but few remain today (Philip and Fisher, 1970). Large herds in the Mascarene Islands were reported by Blyth (1859) to have been exterminated by the time of his writing. Substantial dugong concentrations exist in the vicinity of Antonio Enes, Mozambique (Hughes and Oxley-Oxland, 1971), and stable populations occur in the Pema-Zanzibar Channel and off the Rufigi-Mafia Islands of Tanzania (Kingdon, 1971; Dollman, 1933). Dugongs are more abundant in Kenya and the Somali Republic than elsewhere along the coast of Africa (Philip and Fisher, 1970), with the Kiunga Archipelago and the Lamu Inland Sea supporting the major populations (Kingdon, 1971; Jarman, 1966). Kipini and Malindi, Kenya, also have persistent populations (Jarman, 1966). In the Republic of Somalia, dugongs are still found in Ras Bur Gao and along the archipelago to Kisimayu, on the equator (Travis, 1967; Jarman, 1966). In general, dugongs seem to be less endangered along the east coast of Africa than in most other parts of their range (Fitter, 1968). Dugongs are now extremely rare in the Gulf of Aqaba, the Red Sea, and the Gulf of Suez (Bertram and Bertram, 1966*a*, 1973; Norris, 1960; Gohar, 1957), and they are reportedly extinct in the Laccadive and Maldive islands (Snow, 1970).

The northernmost occurrence in India appears to be in the Gulf of Cutch (Lal Mohan, 1963; Jones, 1960), and further south dugongs have been extirpated from the entire Malabar Coast (Jones, 1967*a*) as well as from the southwestern coast of Ceylon (Deraniyagala, 1965). On the east coast of India, dugongs occur from south of Madras to Cape Comorin (Jonklass, 1960). Overall, dugong abundance in Indian and Ceylonese waters is drastically reduced, and this scarcity is attributable to the increased marine fishery in the area (Bertram and Bertram, 1970*a*, 1970*b*).

The Nicobar, Barren, Narcondom, Coco, and Christmas islands no longer support dugongs, although a few remain in the Andamans (Snow, 1970). Small numbers are found in Burma, the Mergui Archipelago, and Malaysia (Gibson-Hill, 1950), and dugongs have been completely hunted out of Borneo and the Philippines (Philip and Fisher, 1970; Wycherly, 1969). Specimens have been recorded from Hong Kong (Bertram and Bertram, 1973), Formosa (Hirasaka, 1932), and the Ryu Kyu Archipelago (Hirasaka, 1932), but dugongs are presently rare in these areas (Bertram and Bertram, 1973). The range extends east and south to include the Palau Islands (Harry, 1956), the Carolines, the Solomons, New Caledonia, New Guinea, New Hebrides, and Australia (Bertram and Bertram, 1973; Philip and Fisher, 1970; Jones, 1967*a*). According to Rice and Scheffer (1968), dugongs are not present in the Marshall Islands (Philip and Fisher, 1970), or in the Gilbert, Ellice or Fiji islands (Bertram and Bertram, 1973).

The greatest concentrations of dugongs appear in northern Australian waters (Bertram and Bertram, 1973; G. Heinsohn, personal communication).

Along the west coast of Australia, dugongs range as far south as Perth (32°S) (Bertram and Bertram, 1966*b*), and stable populations have been reported for both Shark's Bay and Broome, Western Australia (Macmillan, 1955; G. Heinsohn, personal communication). The shores of the Northern Territory and Queensland support stable dugong concentrations, and dugongs are common in the Gulf of Carpentaria (Bertram and Bertram, 1973; G. Heinsohn, personal communication). Stocks seem to be maintaining themselves and even may be increasing in northeast Queensland (G. Heinsohn, personal communication). Formerly, dugongs occurred along the eastern coast as far south as Sydney; however, Brisbane is now the southern limit of their known range (Macmillan, 1955; MacInnes, 1951).

FOSSIL RECORD. The fossil history of the Dugongidae is extensive, beginning with terrestrial herbivore ancestors present during the early Eocene (Reinhart, 1971). Although their place of origin is unknown, dugongids were at one time world-wide in

FIGURE 3. Photographs of dorsal (top), ventral, and lateral (bottom) views of skull of a dugong (USNM 396962).

FIGURE 4. Photographs of lateral view of skull and articulated mandible of dugong (top) and anterior view of skull (USNM 396962).

distribution and their geographic history involves numerous complex migrations (Simpson, 1932). Earliest known fossils include *Prorastomus* of the Eocene of Jamaica (Owen, 1855), *Thalattosiren* and *Sirenavus* from the European mid-Eocene (Romer, 1966), *Protosiren* from both Europe and North Africa in the middle Eocene (Romer, 1966), *Eotheroides* from the middle–late Eocene of Egypt (Deperet and Roman, 1920; Palmer, 1899), and *Prototherium* of the European late Eocene (Romer, 1966). *Lophiodolus* of South America, *Anomotherium* of eastern Asia (Romer, 1966), and *Caribosiren* of Puerto Rico all date back to the Oligocene (Reinhart, 1959), and *Rytiodus* remains have been unearthed from late Oligocene deposits of Europe (Romer, 1966). Miocene dugongids are *Prohalicore* from Europe, *Indosiren* from the East Indies (Romer, 1966), and *Hesperosiren* from the east coast of North America (Simpson, 1932). *Halitherium* was especially widespread during the Oligocene and the early Miocene (Sickenberg, 1934; Deperet and Roman, 1920); fossils have been discovered over a vast range including Europe (Astre, 1954; Sickenberg, 1934; Lydekker, 1892; Hartlaub, 1886; Adams, 1866), the eastern United States (Kellogg, 1966; Simpson, 1932; Hay, 1922), and the western United States (Kilmer, 1965; Reinhart, 1959). Also present during the Miocene was *Halianassa* found in Europe (Romer, 1966), western North America (Kilmer, 1965; Reinhart, 1959) and eastern North America (Kellogg, 1966; Hay, 1922). Pliocene representatives are *Miosiren* from Europe and *Felsinotherium* of North Africa, North America, and Europe (Romer, 1966).

FORM. The following description of dugong skin is from Gohar (1957). In a 288-cm female, the epidermis was only 2.5 mm thick on the belly. The skin, 35 mm thick on the dorsum and only 25 mm thick on the venter, was characterized as follows: *rete mucosum* with a well-developed layer of columnar cells, *stratum granulosum* of more flattened cells, *stratum lucidum* hardly distinguishable, *stratum corneum* only a few layers of flattened cells, *cutis vera* intensely white, constituting the major thickness of the skin, *corium* merging into the *panniculus adiposus* (blubber), which was not as abundant as in whales. Large amounts of fat were present in the omentum. Numerous cuts and scars are usually present, resulting from encounters with reefs, oyster beds, or other sharp objects. The short, fragile, unpigmented hairs are more numerous on the back than on the belly; few are present on the flippers (Dexler and Freund, 1906*b*). Bristles cover the flattened mouth plate, formed by the upper lip; long, coarse, backwardly directed bristles project on both sides of the fibrous knob in the center of the upper lip; these interlace with similar bristles on the lower lip. Detailed descriptions of hair, spines, and palatal plates are in Gohar (1957).

The skeleton is of extremely dense (pachyostotic) bone. Cranial characters (see figures 3 and 4) are: remarkably enlarged and sharply down-turned premaxilla, nasal basin on the top of the skull extending posteriorly beyond the anterior margin of the orbits, nasal bones absent, zygomatic arches thick and deep, braincase small. Molariform teeth (five or six per jaw) are replaced from the rear by newly erupting teeth. The anteriormost teeth are partially resorbed and lost. Teeth are of cementum and orthodentine, lacking enamel (Flower and Lydekker, 1891). Cheekteeth increase in size from front to rear and except for the last, which is grooved laterally, they are subterete in cross section; roots are simple and open. The inner pair of upper incisors, thought to be deciduous by Heuvelmans (1941), is resorbed early; the outer pair (tusks) protrude into the mouths of males and some females (G. Heinsohn, personal communication). Eight prominent alveoli (four per jaw) containing vestigial teeth are located in the anterior face of the

mandible (Lyman, 1939). Further discussion of tooth succession and possible sexual dimorphism in skulls is in Mitchell (1973). Scheffer (1970) discussed the possibility of determining age by studying growth layers in the dugong tusk. Vertebrae number 57 to 60 (7 cervical, 17 to 19 thoracic, 4 lumbar, 3 sacral, 28 to 29 caudal). Ribs are slender and the sternum is reduced; the scapula has a short acromion; the coracoid is well developed; and the clavicle is absent. The humerus has prominent tuberosites and carpals show a tendency for fusion (Harrison and King, 1965). The pelvic girdle is vestigial. Pubic bones are absent and the ilium and ischium are rodlike (Jones and Johnson, 1967).

The body muscle is dark red and consists mostly of primitive "red" type fibers (Hill, 1945). The large, globular heart has a deep interventricular cleft (Harrison and King, 1965); ventricles are divided almost to their roots on the auriculoventricular fibrous rings (Hill, 1945). Further descriptions of the heart and major blood vessels are in Hill (1945). Each flipper contains an intricate arterial plexus (not a *rete mirabile*), thought to aid in thermal regulation with an estimated maximum change in blood flow of 30-fold (Elsner *et al.*, in Lenfant, 1969).

The small brain, weighing 282 g in a 300 kg female (Dexler, 1912*a*), is characterized by few and shallow sulci on the frontal, parietal, and temporal lobes. *Corpus quadrigemina* are prominent and the *corpus callosum* is well developed. See Dexler (1912*a*) and Hill (1945) for a detailed description of the brain, and see Dexler (1912*b*) for an account of the spinal cord. Ear ossicles are especially large; the malleus is ankylosed to the typanal; the *processus brevis incudis* is joined to the *tegmen tympanum* (Robineau, 1965). This anchoring apparently damps all ossicular vibration (Fleischer, 1971). A short, thick epiglottis completely covers the glottis; thyroid, cricoid and arytenoid cartilages are present (Hill, 1945); vocal cords are absent, but cushionlike protuberances in the larynx may serve the same function (Harrison and King, 1965). A short trachea (only four cartilage rings) is deeply divided by a medial septum (Harrison and King, 1965; Hill, 1945). Dorsoventrally flattened lungs extend posteriorly to the kidneys (Hill, 1945). The lungs differ histologically from those of all other mammals (Engel, 1962); unique vesicles (unlike typical alveoli) arise laterally along the bronchioli and are the sole respiratory units (Engel, 1959); bronchioli are unusually muscular (Engel, 1962), possibly functioning to compress lung air, thus enabling the dugong to sink or surface without the use of flippers or tail, or the expelling of air.

The short tongue (about 14 cm in an adult) is anteriorly truncate, and has little mobility. It is covered with large filiform papillae and clustered retroverted cuticular spines (Gohar, 1957; Sonntag, 1922); numerous taste buds in cup-shaped cavities are located on the rear of the tongue (Gudernatsch, 1907). Large parotid glands are the only salivary glands; tonsils are absent (Hill, 1945). The stomach is simple in form; cardiac and pyloric regions of the gastric mucosa are evident; detailed descriptions of the stomach and accompanying glands may be found in Kenchington (1972) and Owen (1838). The small intestine is thick-walled and has two pyloric caeca; the large intestine is thin-walled and pale in color (Hill, 1945). Colon and rectum are not distinctly divided; a single conical caecum projects from the colon. Just inside the anal margin are 12 globular swellings that may act as anal valves (Hill, 1945). The four-lobed liver is flattened against the almost horizontally positioned diaphragm; both the gall bladder and pancreas are small, but the common bile duct (6 mm in diameter) is long (Hill, 1945). A biochemical analysis of the bile is in Caldwell *et al.* (1969).

Smoothly rounded kidneys are elongate, neither reniform nor lobulate. They are unique in being dipelvic and in having numerous regions of the fibrous network without epithelial covering (Batrawi, 1953, 1957); the arrangement of the renal pyramids suggests a retained segmental structure. The bladder is small; its wall is thick and muscular (Hill, 1945). Abdominal testes lie caudad to the kidneys; os penis, bulbourethral glands, and the prostatic utricle are absent (Harrison, 1969). Ovoid ovaries (about 34 by 17 mm) are enclosed within a peritoneal pouch (Hill, 1945); ovarian histology is unstudied. The long, thin-walled vagina has a keratinized shield arising in the vault region and this shield, surrounding the cervix, extends along the ventral wall of the vagina (Harrison, 1969); each uterine cornus measures about 167 mm in length (Hill, 1945). Illustrations and detailed descriptions of the reproductive organs are found in Harrison (1969). The placenta has been described as diffuse at first, becoming zonary later in development (Turner, 1889), but Harrison (1969) suggested re-examination of the dugong placenta in view of Wislocki's (1935) findings on the manatee placenta, which is zonary and hemochorial.

Ventral to the trachea and posterior to the larynx is the small (5.7 g in an adult) thyroid gland (Hill, 1945). The unusually dense and compact stroma may cause hypothyroidism resulting in pachyostotic bone (Cave and Aumonier, 1967). The thymus is extremely lobulated; macroscopic examination revealed no parathyroids (Cave and Aumonier, 1967). Small, triangular adrenals (2.68 g and 2.61 g in a 1.5-m dugong) are located about 6 cm above the kidneys; they are not histochemically distinct (Fernand, 1951). The spleen is small but exhibits some spleniculi (Hill, 1945). The pituitary weighed 0.54 g in a 1.5-m dugong (Fernand, 1951); *pars tuberalis* and *pars intermedia* of the pituitary are reduced (Hill, 1945).

FUNCTION. Few physiological data are available. Dugongs generally remain submerged for 1.5 to 4 minutes between breaths (Jones, 1967*b*). In 108 timed dives of a 1.8-m female, average submergent time was 181 seconds (range 33 to 506—Kenny, 1967). The interval between opening and closing of nose flaps is about 1.5 seconds (Jones, 1967*b*); interval between surfacing and submerging is from 2 to 6 seconds (Kenny, 1967). Traveling dugongs rise to breathe less frequently than do feeding animals (Jarman, 1966).

Elsner (in Lenfant, 1969) measured the oxygen capacity of the blood as 1.6 to 10. This is unusually low for mammals and is perhaps related to the sluggish mode of life.

ONTOGENY AND REPRODUCTION. Breeding seems to occur throughout the year, with no well-defined season; speculation as to the most active months for reproductive activity is varied (Heinsohn, 1972; Jarman, 1966; Norris, 1960; Macmillan, 1955; Prater, 1929*a*; Anderson and De Winton, 1902). The gestation period is unknown, but it is probably about one year. Opinion as to calving time also is varied, but Heinsohn (1972), Bertram and Bertram (1973) and Norris (1960) presented data from Australia and Ceylon indicating many births during July, August, and September. Macmillan (1955) observed the natural birth of a dugong in late June in Australia. The female reportedly struggled to a point six feet above the water level on a sand bank that was exposed only at low tide. Here, parturition occurred within minutes, with the calf being born headfirst. The female was solicitous in nuzzling and stroking the newborn, which swam with its head above the water, using the flippers only. It was clasped by the female and dunked. It then swam normally with the head submerged and used the tail for stroking. The breathing rate of the calf was about four times per minute; suckling was not seen. A single young usually is born; twins rarely have been reported (Troughton, 1928). Heinsohn (1972) reported a fetal dugong 1.4 m in length, but he also captured several calves between 1.09 and 1.5 m in length; neonates weigh about 20 kg (Heinsohn, 1972; Jones, 1960, 1967*a*). Calves begin grazing within the first three months after birth; all juvenile (1.09 to 1.5 m) dugongs examined by Heinsohn (1972) contained an abundance of sea grasses in their stomachs, as well as milk. Young have frequently been reported "riding" on the backs or shoulders of an adult female (Jarman, 1966; Prater, 1929*b*; Petit, 1927) and a female sometimes will clasp the calf to her side while cruising (Prater, 1929*b*). Young may remain with their mothers for more than a year; calves as long as 1.83 m in length were recorded accompanying females (Heinsohn, 1972; Macmillan, 1955). Examination of reproductive tracts indicates that sexual maturity is attained by the time dugongs reach about 2.4 m in length (Bertram and Bertram, 1973; Heinsohn, 1972). Therefore, three separate age classes are evident: 1) calves, which still accompany their mothers (less than 1.8 m); 2) juveniles, which are independent but not yet sexually mature (1.8 to 2.4 m); and 3) adults, which are capable of reproduction (2.4 m or longer).

Heinsohn (1972) presented a hypothetical growth curve. The largest dugong on record, a female, was 4.06 m in length and weighed 908 kg (Mani, 1960); average adults measure 2.4 to 2.7 m and weigh about 230 to 360 kg. Average longevity in the wild is unknown, but a captive pair was maintained successfully for 10 years before they died (E. G. Silas, personal communication).

ECOLOGY. Definite evidence of predation upon the dugong by animals other than man is lacking. Some fishermen believe sharks prey on dugongs (Kingdon, 1971; Jarman, 1966; Macmillan, 1955), but more than 100 dugongs accidentally netted in shark infested waters of Queensland showed no wounds or scars indicating attack by predators (G. Heinsohn, personal communication). Macmillan (1955) stated that dugongs panic when killer whales approach. Remoras have been seen attached to dugongs (C. Barnett, personal communication) and the presence of a small fish in the prepuce of a male dugong suggested commensalism (Hill, 1945). Barnacles (Chelonobiae and the less numerous *Balanus*) have been observed on the dugong (Marlow, 1962; Dexler and Freund, 1906*b*). Internal parasites are listed in Dailey and Brownell (1972) and Crusz and Fernand (1954). No diseases have been reported.

Based on fisherman's catches from Ceylonese waters, Norris (1960) concluded that the sex ratio was 1:1. In Australia, an equal sex ratio was found only in calves; proportions of older animals favored females (Bertram and Bertram, 1973; Spain and Heinsohn, 1973; Heinsohn, 1972). Thomas (1966) similarly reported a

preponderance of females in Indian coastal waters and sexual partitioning of the habitat has been suggested as a likely explanation (G. Heinsohn, personal communication). Heinsohn (1972) presented data on age composition. A high proportion of young animals was found in the population sampled, but results may have reflected the population decimation that occurred during the preceding year. The tropical or subtropical dugong does not appear to select any particular salinity, and although not known to ascend rivers, dugongs have been found in brackish waters (Kingdon, 1971; Hla Aung, 1967; Jonklass, 1960). Optimal dugong habitat is characterized by: 1) saline waters 2 to 8 fathoms in depth; 2) shelter from rough winds and heavy waves; 3) an abundant food source; and 4) water temperatures of 21 to 38° C (Heinsohn, 1972; Heinsohn and Birch, 1972; Kingdon, 1971; Jones, 1967*a*; Travis, 1967; Jarman, 1966).

There is some regular daily movement between feeding grounds and deeper waters; photoperiod or tidal changes are the suspected triggers for this movement (Kingdon, 1971; Jarman, 1966; Jonklass, 1961). Long distance migration is unknown for dugongs, but seasonal changes in their abundance in local coastal waters are apparent in east Africa, India, and the Philippines (Kingdon, 1971; Jarman, 1966; Funaioli and Simonetta, 1966; Phillips, 1927; Seale, 1915; Anderson and De Winton, 1902). This movement is associated with changing monsoons and may be in response to rough weather or variable food sources. Similar movements have not been reported from Australia.

Dugongs are mostly herbivorous and their historic distribution was broadly coincident with the tropical Indo-Pacific distribution of their food plants, the phanerogamous sea grasses of the families Potomogetonaceae and Hydrocharitaceae (Kingdon, 1971). The most utilized genera throughout the range are: *Diplanthera*, *Halophila*, *Syringodium*, *Zostera*, *Enhalus*, and *Cymodocea*. More detailed dietary data are found in Heinsohn and Birch (1972), for Queensland; Marlow (1962) for New South Wales; Jarman (1966) and Kingdon (1971) for Kenya; Petit (1927) for Madagascar; Prater (1929*a*), Jones (1960), and Jonklass (1961) for the Indian Ocean; Gohar (1957), Anderson and De Winton (1902), and Den Hartog (1970) for the Red Sea and the Malaysian Archipelago. Although sea grasses are the primary food of dugongs, Spain and Heinsohn (1973) noted a change in diet to brown algae (*Sargassum*) following a severe cyclone that caused considerable damage to local sea grass beds. Green algae was once reported from the stomach of a dugong taken in the Indian Ocean (Annandale, 1905), and Hirasaka (1932) reported a Formosan specimen containing marine algae and some crabs.

Dugongs are listed in the IUCN Red Data Book as vulnerable; except in Australia, numbers are much reduced and continuing to decline throughout the range, apparently a result of hunting pressure (Bertram and Bertram, 1973). Legal protection is nearly complete throughout the range, but problems of law enforcement and education remain (Hoffman and Jungius, 1972). At present, no reserves, parks, or sanctuaries have resident dugongs; however, Kenya is planning a terrestrial-marine park in the Lamu region, which supports a stable population. The proposed Kasiti Marine National Park of Kenya in the Shimoni area also supports dugongs (Third Internat. Cong., World Wildlife Fund, Bonn, 1973). Two sites similarly proposed for marine parks in Tanzania would include dugongs (Ray, 1968). Similar sanctuaries were proposed but not established (Fitter, 1968; Jonklass, 1961; Spittel, 1960) for India and Ceylon.

Few dugongs have been held in captivity and no successful breeding in captivity has been reported (Jones, 1960, 1967*a*, 1967*b*). This species has been hunted throughout its range for its meat, likened to tender veal; its hide, used in making a good grade of leather; its oil, 5 to 8 gallons from an average adult; and its bones and tusks, used for both ivory and charcoal in sugar refining (Bertram and Bertram, 1973; Crusz, 1960; Prater, 1929*a*; Phillips, 1927; Annandale, 1905). Commercial dugong fisheries once operated from Ceylon (Prater, 1965) and several different cultures prized certain products of the dugongs for medicinal and aphrodisiac properties (Jones, 1967*a*; Allen, 1942; Hirasaka, 1934). Large gill nets and stealthy harpooning are the usual techniques employed in capturing dugongs. Additional dugong mortality has been caused accidentally by shark netting and marine fisheries within dugong habitat (Heinsohn, 1972; Bertram and Bertram, 1970*a*).

BEHAVIOR. Feeding is the predominant activity of the dugong. Interlacing bristles on the lip pads are used for grasping sea grasses (Gohar, 1957; Prater, 1929*a*), and the roughened mouth plate is used as a "tool" for uprooting roots and tubers (Jarman, 1966; Thomas, 1966). Evidence for rooting action is seen in the tusk wear, suggesting scraping or knocking against a hard substrate (Pocock, 1940). Conspicuous feeding trails through the beds of sea grass further suggest that the shovel-face is used for digging (Jarman, 1966). Gohar (1957), on the basis of calloused flipper edges, hypothesized that the forearms were used in digging; subsequent observations proved him incorrect (Jones, 1960; C. Barnett, personal communication). While grazing, dugongs "walk" along the substrate on their flippers (Jarman, 1966), a behavior similarly reported for the manatee (Hartman, 1971). They also drift along with the flippers dragging against the substrate, thus producing calloused areas (C. Barnett, personal communication). Captives have been observed using the flexible flippers to stuff food masses into the mouth (Jonklass, 1961). After grasping a mouthful of food, the head is shaken in an apparent effort to clean the food (Jonklass, 1961); this action is seemingly effective, for analysis of stomach contents revealed little sand or mud (Spain and Heinsohn, 1973; Heinsohn and Birch, 1972; Prater, 1929*a*).

Jarman (1966) reported that dugongs feed at night, and Kingdon (1971) contends that tides are even more important than photoperiod in regulating feeding activity. He claimed that dugongs feed with the rising tide, following it out with the ebb. Colin Barnett (personal communication) observed dugongs in Australia coming inshore most often on a rising tide, whether at dawn or dusk, although most commonly on overcast days.

Locomotion is accomplished by vertical stroking of the tail; flippers are usually tucked to the sides (C. Barnett, personal communication). Average cruising speed is about 10 km per hour (Jarman, 1966), but fleeing dugongs have been estimated to swim at almost twice that speed over short distances (Jonklass, 1961). The only grooming behavior thus far reported is that of rolling and rubbing the body in the sand (C. Barnett, personal communication).

Whistling sounds of frightened dugongs have been reported (Kingdon, 1971); calves have a bleating lamblike cry (Troughton, 1947). Dugong vocalizations are believed to be used only for short range communication (Kingdon, 1971).

Dugongs once occurred in herds up to several hundred (Stoddart, 1972; Bertram and Bertram, 1966*b*; Annandale, 1905); large herds are now rare, although Travis (1967) reported a herd of up to 500 off the coast of Somali. These animals were not elusive; calves left the herd in the afternoon to form a nursery near the shore; when Travis waded into the water, the calves swam about his legs, rubbing against them. Groups of up to six individuals are now most common (Hughes and Oxley-Oxland, 1971; Kingdon, 1971; Jarman, 1966; Troughton, 1947; Prater, 1929*a*); sex and age composition of these groups varies. Calves may accompany their mothers for more than a year, forming a stable social unit for that time (Macmillan, 1955); males are not believed to remain with such units (Jarman, 1966). Wariness is probably a direct result of hunting pressure (C. Bertram, personal communication). Several small groups may converge to feed and associate within the same area. In Kenya, associations of more than 80 individuals have formed in recent years; although uncommon, they occurred most frequently during the peak of the hot season (Jarman, 1966). A concentrated food source or the synchronized estrous of several cows, attracting many bulls, may explain such congregations.

Dugongs tame quickly, a fact which is taken by some as evidence of a high degree of intelligence (Jonklass, 1961; Troughton, 1947), but a pair held captive for 6½ years exhibited no noticeable change in behavior and never appeared to recognize their feeders (Jones, 1967*a*). Play has been rarely observed (Jonklass, 1961); fights or aggressive behavior have not been recorded. A degree of sociability was indicated when one of a pair was captured and the other lingered about the area, apparently seeking the companion (Troughton, 1947); likewise, the male of a captive pair made vigorous attempts to prevent separation from the female according to Jones (1967*a*). He also provided a detailed description of attempted mating of a pair of captive dugongs in India in April 1966. This behavior is thought to occur in sheltered bays under natural conditions (Kingdon, 1971).

GENETICS. Nothing is known of the genetics of this species.

REMARKS. The dugong was named *Amblychilus* by Fischer (1814:638), but because it is not binomial, and no type species was designated, this name is not included in the synonymy.

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